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ABSTRACT

The effects of four different instructional presentations of identical content on the achievement of 72 gifted seventh graders were evaluated. Ss were randomly assigned to four treatments, each with one replication: (1) independent study, (2) lower-order questions, (3) higher-order questions, and (4) divergent-production questions. Eight teachers were trained to follow detailed scripts in presenting a unit on plate tectonics. Ss received identical curriculum content with variations in the teachers' questioning approaches. Ss in the independent study group individually directed their own instruction while monitored by a teacher. Results of testing (multiple-choice and short-answer) on the fifth day revealed that the lower level questioning groups outscored higher-order treatment groups on total achievement scores. There were no significant differences on the delayed-retention tests (administered 5 weeks after the first testing period). Knowledge loss was greatest for the lower order group. The independent study group did well, scoring significantly below others on only one achievement measure. Attitude inventories toward science and instruction revealed significant sex differences in attitudes. (Author/CL)

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AN INVESTIGATION OF THE EFFECT OF FOUR DIFFERENT INSTRUCTIONAL STRATEGIES ON THE ACHIEVEMENT OF GIFTED SEVENTH-GRADE STUDENTS IN A SPECIFIC CONTENT AREA

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THE EFFECT OF FOUR DIFFERENT INSTRUCTIONAL STRATEGIES ON THE ACHIEVEMENT OF GIFTED SEVENTH-GRADE STUDENTS

by

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ABSTRACT

This study investigated the variable effect of four different instructional presentations of identical content on the achievement of gifted seventh graders. Seventy-two high achieving students were randomly assigned to four treatments, each with one replication: (1) Independent Study, (2) Lower-Order Questions, (3) Higher-Order Questions, and (4) Divergent-Production Questions. The treatments were four 55-minute class periods.

Eight teachers were trained to follow detailed scripts in presenting a unit on plate tectonics. All students received identical curriculum content with variations being in the teacher's questioning approach. The independent study group individually directed their own instruction while monitored by a teacher. Teachers were trained in all treatment presentations and assigned at random to treatments.

Testing occurred on the fifth day with follow-up five weeks later. Students responded to a multiple-choice test and a short-answer test. Immediate post-test results on the lower-order question subscale of the multiple-choice test favored ($p < .05$) the lower-order treatment over the independent study and higher-order treatments. The lower-level

groups also significantly ($p < .05$) outscored the higher-order treatment groups on the total achievement test. On the delayed-retention, all significant differences disappeared. Knowledge loss was greatest for the lower-order group.

Attitude inventories toward science and instruction were also administered. Significant sex differences in attitude toward science were found as was a significant difference in attitude toward instruction.

AN INVESTIGATION OF THE EFFECT OF FOUR DIFFERENT INSTRUCTIONAL STRATEGIES ON THE ACHIEVEMENT OF GIFTED SEVENTH-GRADE STUDENTS IN A SPECIFIC CONTENT AERA*

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Increasingly, regular classroom teachers are being called upon to provide a qualitatively different experience for gifted students without recourse to additional funding, resource teachers, or pull-out programs. Gallagher (1975) has argued that changes in the method of presentation of material is one of the better ways of accommodating the gifted, along with possible changes in content and classroom atmosphere. Several authors (Clark, 1979; Williams, 1970) offer entire books of teaching strategies for meeting the needs of the gifted.

In general, the promotion of particular instruction strategies for the gifted are focused upon several definitional characteristics of the gifted: they learn rapidly, can reach higher levels of competence and abstractness earlier, and can produce original (often divergent) thoughts with respect to a given content domain. Unfortunately, the fervor with which strategies to satisfy the characteristics of gifted students are recommended is not matched by a similar fervor to do and report empirical studies which demonstrate that the strategies are more appropriate for such children. In fact, the claim of superiority for certain instructional strategies is only poorly supported by available data (Dunkin & Biddle, 1974).

*Paper read at the Annual Meeting of the American Educational Research Association, Montreal, Canada, April 1983.

Prominent among the strategies proposed for use with the gifted are certain questioning approaches. Questioning techniques are universally used to engage learners with content, and their ubiquitousness in the classroom and the frequency with which various questioning strategies are recommended for use with the gifted prompted the selection of questioning as the topic of this investigation.

Four questioning types were chosen:

1. Bloom's (1956) Taxonomy of Educational Objectives calls for higher-order questions which elicit analysis, synthesis and evaluative thought. Questions of this type are called higher-order questions in this study.
2. At the other end of Bloom's taxonomy are questions which call for memory or comprehension of ideas to which an individual is exposed. In this study, knowledge and comprehension questions are called lower-order questions.
3. Guilford (1956) has suggested a cluster of questions which call for quantity, reorganization, and point of view (role-taking) responses. These questions are referred to as divergent-production questions herein.
4. Logically, another possible questioning strategy is the absence of teacher questions entirely. This treatment is called independent study.

The problem this study set for itself was that of determining which questioning strategy (lower-order, higher-order, divergent-production, or independent study) was best suited to helping high achieving (90th percentile on a nationally normed test) seventh-grade students acquire

science information appropriate to their age and grade. Outcome measures responded to be the students encompassed the three active questioning strategies (higher-order, lower-order, and divergent-production questions).

METHODS AND PROCEDURES

Materials Development and Pilot Study

Specific materials were developed for the study at the University of Wisconsin-Madison:

a. A 20-page text on plate tectonics (common to all treatments), which was reviewed by science education experts for content integrity.

b. Instructional scripts for teachers of all four treatments, reviewed by education professors and teachers of gifted.
   1. 75% of the questions at the knowledge-comprehension level (lower-order)
   2. 75% of the questions at the synthesis-evaluation level (higher-order)
   3. 75% of the question calling for quantity, reorganization or viewpoint responses (divergent-production)
   4. Script for administering independent study

c. Student Study Guide
   1. Higher-order guide
   2. Lower-order guide
   3. Divergent-production guide
   4. Independent study guide

d. Three tests of learning outcomes

   1. A twenty-two item lower-order question scale

   2. A twenty-two item higher-order question scale

   3. A four-item divergent-production question scale

e. All materials were piloted in an exact replication of the processes of the study two months before the study was begun.

Population and Sample

The population (N = 100) consisted of all students in the seventh grade at Oconomowoc (Wisconsin) Junior High School achieving above the 90th percentile according to national norms on the California Achievement Test administered during the fall of their seventh-grade experience.

The sample consisted of 72 students assigned at random to each of the four instructional treatments with nine students in each of eight instructional groups (one replication per treatment). Blocking by sex was done to achieve balance within groups.

Instructors

Instructors were six Oconomowoc Junior High School faculty currently teaching science or with an appropriate science background. Instructors received training in three instructional techniques (lower-order, higher-order, divergent-production questions) and were assigned at random to instructional treatments (two teachers at random to each active questioning treatment). The independent study groups were administered by the principal and by a colleague of the investigator,

both of whom received training. They were assigned at random to the independent study groups.

Setting

Instruction took place on four successive days in a common 55-minute, class period. No extraordinary events disrupted either the instruction or the testing, which occurred at the school on the fifth day and subsequently five weeks later.

Instruments

A. Standardized

1. Coopersmith (1967) Self-Esteem Inventory (Hoyt r = .88)
2. Attitude Toward Earth Science Inventory (Klausmeier, 1976) (Hoyt r = .81)

B. Developed

1. 44-Item Achievement Test (Hoyt r = .67)
2. 22-Item Lower-Order Scale (Hoyt r = .57)
3. 22-Item Higher-Order Scale (Hoyt r = .45)
4. Provocative Questions - Inter-rater agreement of 98% was achieved on scores
5. Attitude Toward Instructional Treatment (Hoyt r = .75)

Testing

Tests were administered by the school principal in large group settings on the fifth day of the study and again five weeks later.

Fidelity to Treatment

To assure fidelity to treatment, all lessons were scripted. In addition, each class session was audio-taped. The investigator reviewed all audio-tapes each day and provided feedback to each instructor prior to the next lesson.

Finally, a Fidelity to Treatment coding scale was devised. Using it, a double-blind scoring situation was devised for scoring the audio tapes. The observer recorded a 92% agreement between the type of question called for in the script and those actually used in the instructional setting.

Design

The design was a randomized 4 group, post-test only, with one replication in each group (to nullify possible teacher affects). The independent study group served as a no-question control group and as one of the treatments. Data from the two groups in each treatment were pooled and considered as one group.

Analysis

A series of 2 (sex) by 4 (treatment) analyses of variance was utilized. When a significant ($p < .05$) F ratio was noted, Scheffé post hoc procedures were used to locate the significantly differing means.

All data were analyzed using the library program Statistical Package for the Social Sciences (SPSS) at the Madison Area Computing Center, a facility of the University of Wisconsin System.

RESULTS

Post-test

The analysis of variance (Table 1) for the lower-grade subscale revealed a significant ($p < .001$) difference. Scheffé procedures revealed that the lower-order treatment group did significantly better on lower-order questions than did either the higher-order or independent study groups. These discrepancies are graphed in Figure 1.

TABLE 1

Analysis of Variance on Posttest For Two Sexes and Four Treatments on Lower-Order Questions

Source	Sum of Squares	df	Mean Square	F	Significance
Group	208.049	3	69.350	9.445	.001*
Sex	9.563	1	9.563	1.302	.258
Group x Sex	21.530	3	7.177	.977	.409
Residual	469.907	64	7.342		
Total	703.778	71	9.912		

*$p < .01$.

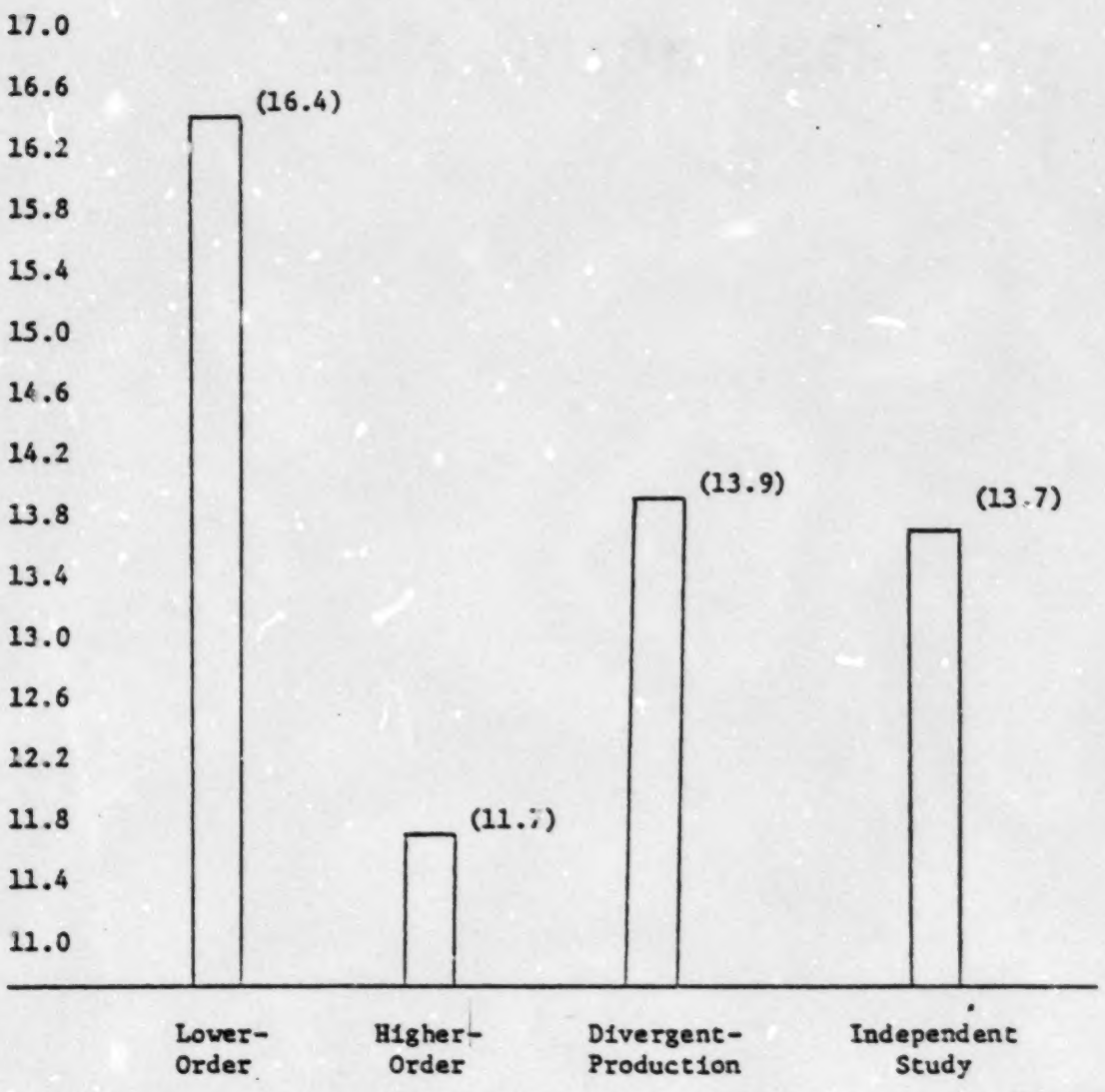

Figure 1. Graph of the significant effect for treatment on the lower-order questions of the posttest.

The higher-order subscale analysis resulted in the F ratio being not significant either for sex or treatment. The total test score analysis (Table II) resulted in a significant ($p < .006$) F ratio. The Scheffe' post hoc procedure located that difference to be between the higher-order and lower-order treatment groups as shown in Figure 2.

This might have been expected from the results of the lower-order subscale, but it did not hold true for the independent study group which was not significantly different from the lower-order group on the total test.

Analysis of the divergent-production material showed no significant difference attributable to sex or group.

TABLE II

Analysis of Variance on Posttest For Two Sexes and Four Treatments on the Total Multiple-Choice Achievement Test

Source	Sum of Squares	df	Mean Square	F	Significance
Group	291.484	3	97.161	4.549	.006*
Sex	58.430	1	58.430	2.736	.103
Group x Sex	36.105	3	12.035	.564	.641
Residual	1366.853	64	21.357		
Total	1734.319	71	24.427		

*$p < .01$.

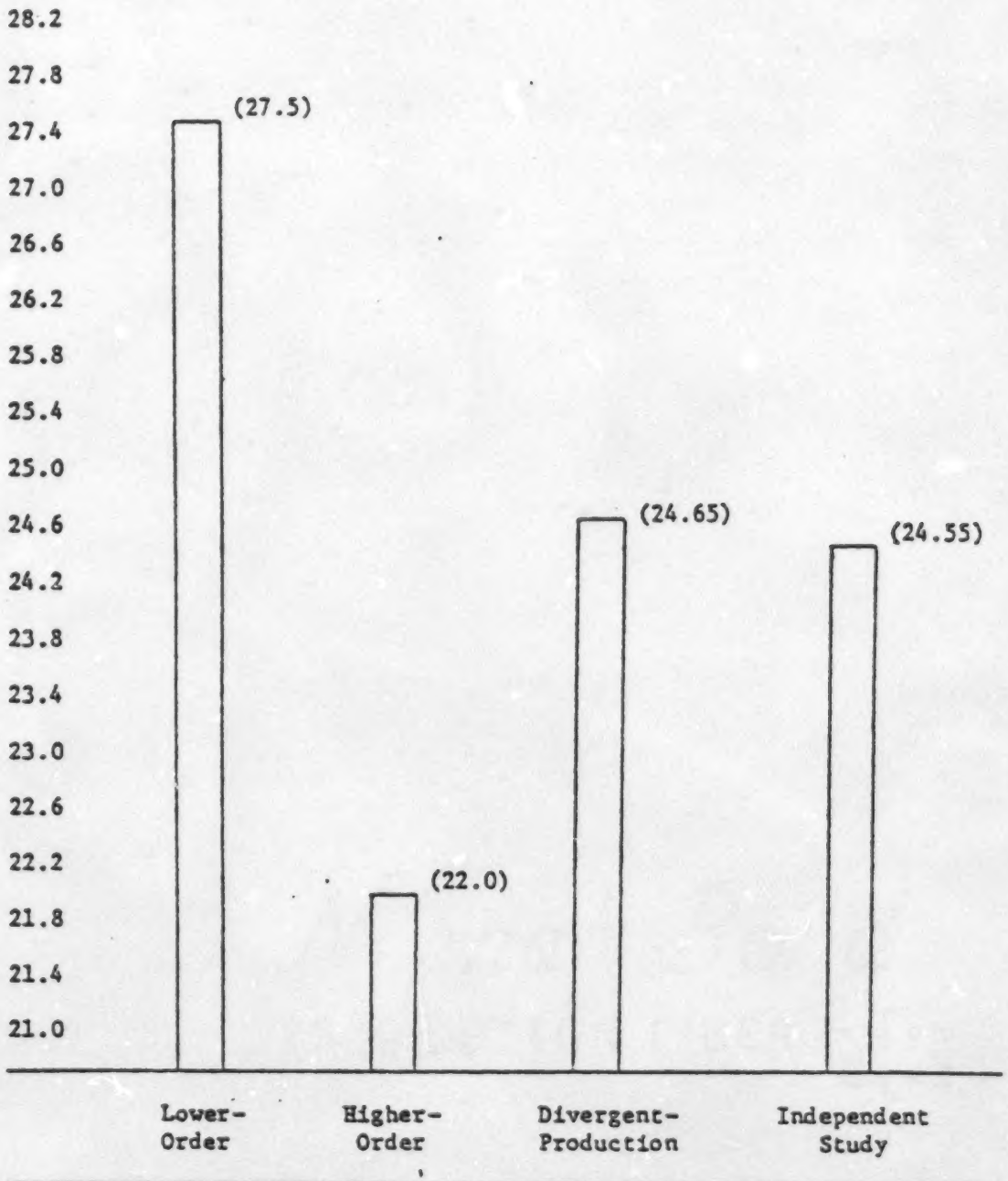

Figure 2. Graph of means for the significant treatment effect on the total multiple-choice achievement posttest.

Delayed-Retention

Five weeks later, the same tests were re-administered. At this time no significant differences were found between sexes or groups on any of the achievement scales. Differences which had existed for immediate testing disappeared during the delay period.

Self-Esteem

The Coopersmith Self-Esteem Inventory results were correlated with the total achievement test score results. The Pearson product moment correlation ($r = .09$, $p > .05$) was not significant. This suggests that self-esteem, as measured, was probably not a source of the differences located earlier.

Attitude Toward Earth Science

The product moment correlation between the Earth Science Inventory and the total score for the post-test achievement inventory was .20. This modest correlation was significant ($p < .05$) suggesting that student attitude toward earth science may have contributed to better scores.

Attitude Toward Instruction Inventory

A 2 x 4 analysis of variance was run on the results of the Attitude Toward Instruction Inventory which was administered during the delayed-retention test setting. The analysis revealed a significant F ratio ($p < .009$) as shown in Table III.

TABLE III

Analysis of Variance for Attitude Toward Instruction Inventory

Source	Sum of Squares	df	Mean Square	F	Significance
Group	1121.442	3	373.814	4.158	.009*
Sex	259.356	1	259.356	2.885	.094
Group x Sex	578.018	3	192.673	2.143	.103
Residual	5753.624	64	89.900		
Total		71			

$p < .01$.

The Scheffe post hoc revealed that this difference was between the divergent-production question group and the independent study treatment group. The provocative-question group liked its treatment significantly more than did the independent study group. This attitude toward treatment was not reflected by a significant difference in achievement test results, however.

Sex Differences

One significant sex difference effect was found: The Attitude Toward Earth Science Inventory (Table IV). Males were more favorably disposed to Earth Science than were females. This attitude did not reflect itself in significant sex effects on any of the achievement variables.

TABLE IV

Analysis of Variance for Attitude Toward Earth Science Inventory

Source	Sum of Squares	df	Mean Square	F	Significance
Group	442.243	3	147.414	2.239	.092
Sex	543.204	1	543.204	8.249	.006*
Group x Sex	84.166	3	28.055	.426	.735
Residual	4214.295	64	65.848		
Total		71	73.314		

*p < .01.

Retention Loss

Post hoc investigations were done to determine knowledge loss within all groups. The t values for correlated measures displayed in Table V shows that five of the changes over time were significant: (1) the lower-order group on the lower-order subscale; (2) the lower-order group on the total multiple-choice test; (3) the independent study group on the lower-order subscale; (4) the independent study group on the total multiple-choice test; and (5) the divergent-production group on the higher-order subscale.

The percentage of loss or gain from post-test to delayed retention test is shown in Table VI. The greatest average loss (12.25%) was by the lower-order treatment group. Overall loss was least for the divergent-production group (1.51%), followed by the higher-order group (4.02%) and the independent study group (4.38%).

TABLE V

Means, Standard Deviations, and Correlated t Values of Achievement for Four Groups

Group			Lower-Order Subscale	t✓	Higher-Order Subscale	t	Total Multiple-Choice Test	t	Short Answer Essay Test	t
Lower-Order (n = 18)	Post	$\bar{x}$	16.44		11.05		27.50		17.06	
		σ	3.43		2.48		5.44		5.10	
				-9.02*		-1.48		-3.30*		-.17
	Delayed	$\bar{x}$	12.94		10.00		22.94		16.83	
		σ	4.05		3.45		6.89		5.16	
Higher-Order (n = 18)	Post	$\bar{x}$	11.72		10.27		22.00		17.11	
		σ	3.75		2.69		4.17		3.49	
				-1.84		+0		-1.85		-.27
	Delayed	$\bar{x}$	10.67		10.28		20.94		16.78	
		σ	2.45		3.14		4.29		4.93	
Divergent (n = 18)	Post	$\bar{x}$	13.94		10.61		24.56		18.72	
		σ	2.60		3.07		4.85		3.89	
				-1.21		+2.42*		-1.25		-1.38
	Delayed	$\bar{x}$	13.16		11.28		24.44		17.33	
		σ	2.85		2.08		4.10		4.37	
Independent Study (n = 18)	Post	$\bar{x}$	13.66		10.88		24.56		14.94	
		σ	2.30		2.32		3.93		5.02	
				-2.15*		-1.21		-2.12*		+.42
	Delayed	$\bar{x}$	12.55		10.06		22.61		15.83	
		σ	2.99		2.86		5.16		4.64	

✓ t for correlated samples.

* $p < .05$.

TABLE VI

Percentage of Loss or Gain Posttest to Delayed Retention

Test on Achievement Measures for Four Groups

	Lower-Order	Higher-Order	Total Test	Essay	Average Loss
Lower-Order	3.5/16.44* 22%	1.05/11.05 9.5%	4.56/27.5 16.5%	.23/17.06 1%	12.25%
Higher-Order	1.05/11.72 9%	.01/10.28 .09%	1.06/22 5%	.33/17.11 2%	4.02%
Divergent-Production	.77/13.94 5%	.67/10.61 6% (gain)	.12/24.56 .04%	1.39/18.72 7%	1.51%
Independent Study	1.12/13/67 8%	.83/10.88 7.5%	1.95/24.56 8%	.89/14.94 6% (gain)	4.38%
Average Loss	11%	2.8%	7.4%	1%	

*Change score divided by mean of posttest.

DISCUSSION

The significant advantage enjoyed by the lower-order treatment group on the lower-order subscale and total achievement test scores is consistent with results reported by others (Clark et al., 1979; Gall et al., 1978) in studies where heterogeneous groups of students were the subjects. Researchers (Ryan, 1973; Clark et al., 1979) have also reported no significant differences between groups on higher-order multiple choice and essay exams. The loss of advantage over time is consistent with research (McLeish, 1968) showing rapid and substantial loss of factual information, and the loss does not appear to be a function of ability (Feldhusen, Check & Klausmeier, 1961). Gifted students lose as much as regular students.

Several reasons might be considered for the achievement advantages shown by the lower-order questioning groups on post-test measures: One is the time period of the study. The four-day instruction period may have been enough time for learning the basic information stressed in the lower-order treatment, but insufficient time for students to acquire more complex concepts such as those emphasized in higher-order and divergent-production treatments.

The strength of the lower-order treatment might also be due to familiarity with the treatment. Classroom emphasis on lower-order questions has been reported consistently (Gall, 1970), even when teachers are working with gifted students (Gallagher, 1965). Students in higher-order and divergent-production treatment groups may have found themselves in relatively novel learning situations without

sufficient time to adjust to the new experience. Two other explanations for the lower-order results are that the instructional scripts did not adequately facilitate the instructional goals of the higher-order and divergent-production treatments or that the measures were not adequate for measuring the learning which occurred in higher-order and divergent-production groups.

Regarding the changes in scores from post-test to delayed retention test, a note of caution is in order: Significant changes in scores reflect a difference in items missed ranging from .67 items to 4.5 (Table V). A change based on the .67 items may be statistically significant, as in one instance here, but not necessarily meaningful. A difference of 4.5 items (of a total of 44), however, holds more interest. This was the loss shown by the lower-order group on the total multiple-choice achievement measure over the five-week period. Since a major goal of education is to insure long-term retention, this substantial loss over time by the lower-order group is of concern.

Further, the 22 percent loss on the lower-order subscale by the lower-order treatment group from post- to delayed retention test is noteworthy (Table VI). Their overall loss was 12.25 percent. The least overall loss of 1.51 percent by the divergent-production group suggests that material acquired within this group was more likely to be retained over time. The group even showed a slight gain on the higher-order subscale.

The relatively small loss of information by the divergent-production group might be related to two factors: One is the attitude of the students toward their instruction: They liked their treatment more than

others, and this affective component might have contributed to better retention. Secondly, previous research (Tyler, 1934) on student retention of materials and skills revealed a gain when students were required to interact with materials in new ways and to interpret these experiences. Divergent-production questioning may place such demands on students. The findings on retention and attitude related to this treatment suggest that teachers planning educational experiences for gifted should consider incorporating this questioning strategy in their repertoire.

An unexpected finding was the performance of the controlled independent study group. Working without teacher interaction, except the oral presentation of the daily assignment, this group did well. On only one achievement measure, the lower-order subscale of the multiple-choice post-test, did the independent study group do significantly worse than any other group. And on the multiple-choice total test, the independent study group had a higher average than the higher-order questioning treatment on both post-test and delayed retention (See Table II). Further the independent study groups was more efficient under self-directed study. Individually, the students determined how much time to give to a lesson each day; they spent an average of 16 minutes per day on their assignments, a total average of 64 minutes over the four days. Other groups worked with the material for 52 minutes each day, a total of 208 minutes.

The independent study group's performance provides support for the belief that gifted students can and should take more control of what and how they learn. Although they liked their treatment significantly

less than did the divergent-production group, in this case their achievement was not affected by this attitude. Teachers of high ability students should capitalize on this capacity to learn independently and develop structures for students in which they find themselves having pleasant learning experience as well as meaningful ones.

To determine whether sex differences might help explain findings, sex differences were investigated. A significant difference between males and females in their attitude toward the study of earth science was revealed, with males having a more positive attitude toward the content than females. This finding has precedent in other research (Fox, 1977); females in junior high school, including gifted ones, often indicate a less favorable attitude toward math and science than males.

Fox has reported that achievement is negatively affected by a more negative attitude toward math and science on the part of gifted girls. That did not happen here; girls and boys achieved equally well. It is possible that this is due to the study's short duration. In general, Fox's interventions have been for longer periods of time, where attitudinal differences may come to play a more predominant part in achievement.

The results of this study do not provide an answer to the question of the relative efficacy of the four questioning treatments under investigation on the achievement of gifted students. Indeed, findings seem to call into question the assumption that the more able students will prosper academically with the use of higher-order and divergent-production questioning strategies. Although there is some support from

findings for divergent-production questioning, higher-order and divergent-production questioning did not result in significantly better achievement.

Nevertheless, these instructional strategies for gifted cannot be dismissed. Students need to have more consistent, long-term experiences with higher-order and divergent-production conception processing, and the effect of this on achievement must be tested over time. In this study, the time factor is a serious limitation. A replication of this study with a four-to six-week time span would be helpful in empirically responding to the question of which teaching strategies are particularly appropriate for the gifted.

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